

# Three Keys to Success in Science for Students with Learning Disabilities

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Rudy is a 12-year-old boy with a learning disability (LD). This is his first year in middle school and, although he still has difficulty navigating the large school, he enjoys the increased freedom and responsibility. However, Rudy isn't looking forward to Friday because midterm progress reports will be sent home to his parents. Despite his best efforts, Rudy knows he is struggling in his life science class. In elementary school Rudy enjoyed science, particularly learning about insects. Unfortunately, as the vocabulary and concepts have become more difficult for him to understand, he has withdrawn from participating and actively learning in his science class. (Please note that Rudy is a fictional character.)

The middle school science curriculum used at Rudy's school is inquiry based, which is much different from the traditional textbook instruction that was used at his elementary school. Because Rudy is not reading at grade level, this inquiry approach has reduced some of his previous anxiety associated



with reading the textbook. With Rudy struggling with some of the procedural aspects of the scientific investigations, His teachers have also noticed that he is having a hard time synthesizing the information from the hands-on activities into main ideas as well as determining the meaning of many of the vocabulary words. Sometimes he also struggles with making basic decisions, such as how he should display the results he found from an investigation. Un-

fortunately, in his inquiry science classroom, Rudy now spends most of his time in science as a spectator while others are actively engaged. As a result, he has not gained a strong understanding of the course content.

## Students who struggle in science

On average, students with LDs score almost one standard deviation lower than students without disabilities on science achievement tests (Anderson 1998). Similarly, 4th-, 8th-, and 12th-grade students with disabilities scored significantly lower than their nondisabled peers on the National Assessment of Educational Progress science test (NCES 2011).

**FIGURE 1** Examples of big ideas and graphic organizers

BIG IDEAS	GRAPHIC ORGANIZERS	EXPLANATION
Cells do many things	<p>Concept Map</p> <pre> graph TD     A((Cells Do Many Things)) --&gt; B((Provide Energy for Work))     A --&gt; C((Take In Nutrients))     A --&gt; D((Divide))     A --&gt; E((Grow))     A --&gt; F((Have Specialized Jobs))     A --&gt; G((Tissue))     G --&gt; H((Muscle))     G --&gt; I((Organ Systems))     G --&gt; J((Organs))         </pre>	<p>Concept maps help connect big ideas to numerous smaller concepts showing how things relate and interconnect. A concept map should be created by a teacher for planning purposes, but can also be created by students to assess understanding.</p> <p><i>This concept map connects the big idea of "Cells do many things" with other smaller related concepts.</i></p>
	<p>E-Chart/Pitch Fork</p> <pre> graph LR     A[There are many types of body cells] --- B[Brain cells]     A --- C[Stomach cells]     A --- D[Bone cells]         </pre>	<p>E-charts are used to highlight main ideas or concepts to within a single idea.</p> <p><i>This E-chart shows the relationship of three specific types of cells in the body.</i></p>

## Supports for students in inquiry classrooms

The National Science Education Standards call for teachers of science to plan "an inquiry-based science program for their students" (NRC 1996, p. 30). The hands-on investigations, decreased focus on rote memorization, and performance-based assessments found in inquiry classrooms benefit students with LDs (Scruggs and Mastropieri 2007). However, students with LDs often need additional supports and structure in these types of classrooms to be successful. Three simple ways teachers can enhance the achievement of students with LDs are by (1) focusing on big ideas, (2) using graphic or-

ganizers, and (3) providing mnemonic strategies to help students learn important facts. See Figure 1 for examples using big ideas and graphic organizers. Figure 2 illustrates an example of a mnemonic, and Figure 3 indicates the research from which the examples originate.

## Big ideas

Students like Rudy often get overwhelmed trying to learn novel and complex science terminology. Hand et al. (2009) explain that "knowledge is stored in long-term memory as conceptual frameworks, not as separate content knowledge points" (p. 32). Consequently, when learning takes place,

an individual's conceptual framework is rearranged and strengthened. Students with LDs in particular benefit from focusing on big ideas because this reduces the volume of information that needs to be memorized and provides an anchor (i.e., the big idea) to tie important concepts together.

Big ideas are concepts the teacher wants to ensure students internalize at the end of a science unit. In order to develop a big idea, a handful of key ideas for students to master should first be formed. State and national science standards can be used to guide the development of central concepts or big ideas (Hand et al. 2009). Oftentimes, however, state and national standards do not provide the exact objectives for the teacher to teach, so the teacher must develop the big idea based on content knowledge pertaining to the standard. For instance, in a

life science content standard that states students should understand and apply knowledge "of the structure and function in living systems" (NRC 1996, p. 106), a variety of big ideas can be generated. After looking at this standard and examining the relationships between the ideas related to the standard, we generated the big idea "Cells do many things" (see Figure 1).

Through instruction, experimentation, and observation tied explicitly to the big idea, students gain an in-depth understanding of overall science concepts.

### Graphic organizers

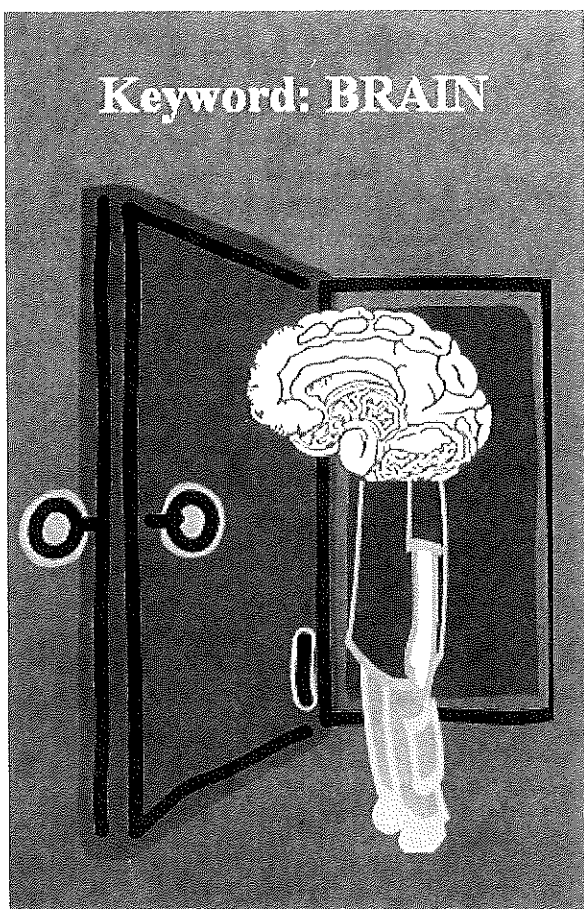
Rudy's science teacher, Ms. Greene, occasionally uses graphic organizers. In the unit where she used a graphic organizer, Rudy obtained his highest score (i.e., 88% instead of his average 60%) on the summative test. The graphic organizer Rudy could have completed for the first unit is shown in Figure 1. Similar to all graphic organizers, this one visually displays the connection between ideas (Ellis and Howard 2007). This connection can express a hierarchical relationship, demonstrate cause and effect, compare and contrast two items, or symbolize a cyclical or a linear flow. Additionally, these images can act as a visual prompt for communication and understanding of complex relationships and important information.

### Mnemonics

Rudy struggles with remembering key vocabulary words. Mnemonics may help him remember important terms or concepts. Mastropieri and Scruggs (1998) describe the use of mnemonics as a systematic way of enhancing memory input or encoding that makes information easier to access or retrieve. As identified by previous research, there are a number of specific mnemonic strategies that teachers and students can use. Some of the specific mnemonic strategies detailed by Mastropieri and Scruggs (1998) include the keyword method and the letter strategy (e.g., using letter prompts). The keyword mnemonic strategy pairs the keyword with an illustration, demonstrating how the keyword is related to the vocabulary word. The keyword and the illustration are used as a prompt for students to redevelop the correct definition of the represented vocabulary word (Atkinson 1975). Figure 2 demonstrates a possible keyword mnemonic Ms. Greene could have created to help Rudy remember the definition of

**FIGURE 2**

The keyword mnemonic strategy for *cell membrane*



the word *cell membrane*. In the example, the keyword *brain* is used for the vocabulary word *cell membrane*. The figure shows a brain walking through a door because the cell membrane acts as a door through which particles pass back and forth. If Rudy were to study using this mnemonic strategy, when he saw the vocabulary word *cell membrane* he would be prompted to remember the keyword *brain*. Then he would remember the illustration and recall that the cell membrane is like a door that allows things to move in and out of the cell.

## Conclusion

Struggling students with LD will benefit greatly from graphic organizers and the use of mnemonic devices to learn unfamiliar vocabulary. The identification and exploration of the big ideas in connection with a student's prior knowledge can also help create a strong environment of learning for a diverse population of students. Successfully implementing these strategies into science classrooms will prevent students like Rudy from becoming spectators in a content area filled with hands-on learning. ■

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**FIGURE 3**

Research supporting strategies presented in this article

Strategies	Articles
Big ideas	Archer and Hughes (2011) McCleery and Tindal (1999)
Mnemonics	King-Sears, Mercer, and Sindelar (1992) Mastropieri, Scruggs, and Levin (1985)
Graphic organizers	Dexter and Hughes (2011) Griffin, Simmons, and Kameenui (1991)

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